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AN ASSESSMENT OF ROOT DISEASES IN THE NORTHERN REGION

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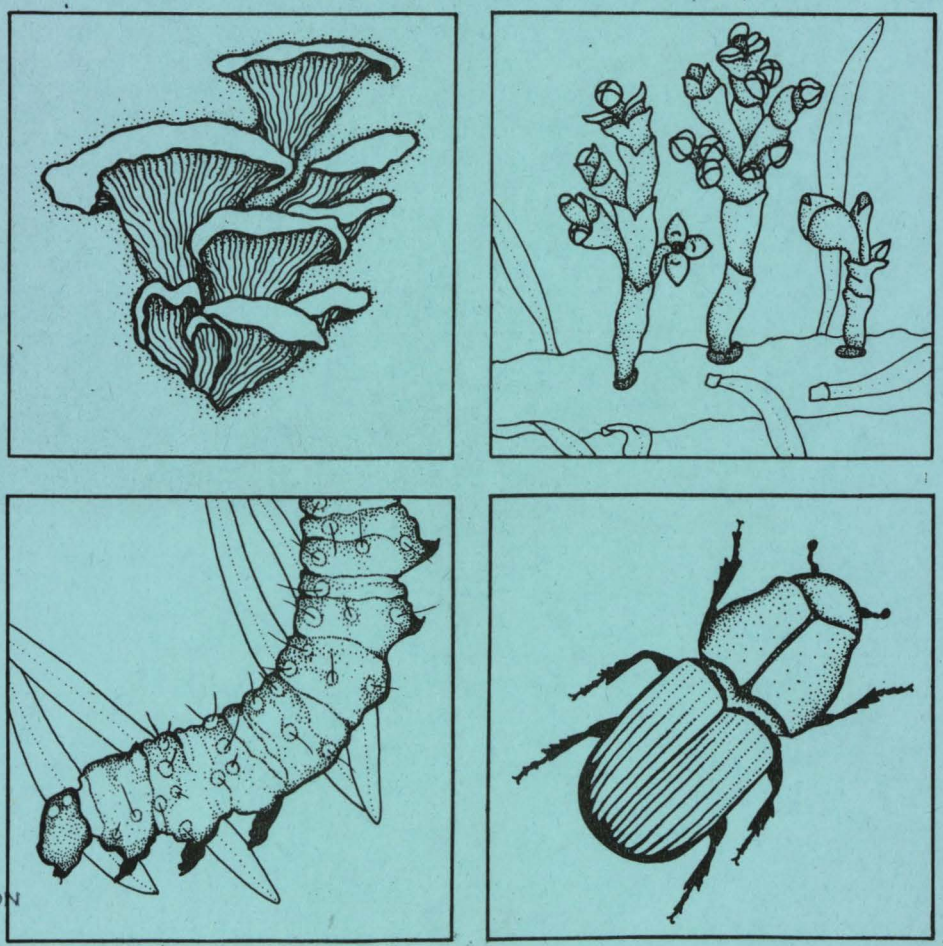
by

James W. Byler



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AN ASSESSMENT OF ROOT DISEASES IN THE NORTHERN REGION

by

James W. Byler, Supervisory Plant Pathologist

ABSTRACT

Root diseases are badly neglected threats to timber production. Annual root disease associated mortality is estimated at 80.7 MM ft^3 (387 MM bd. ft.). Damage appears to be increasing. This paper describes types of root disease damage in the Region, estimates the losses they cause, states some concerns regarding the threat of these pests to timber production, and outlines information needs.

INTRODUCTION

Root diseases caused by native pathogens have been known to occur in western forests for many decades. The early literature frequently refers to butt rot in old-growth stands, and sometimes to root disease-caused tree mortality. But until recent times, their threat to timber production has not been recognized. Pathologists and foresters have not given root diseases the emphasis they have other forest diseases, such as white pine blister rust and dwarf mistletoes.

The recognition of the root disease threat to young-growth stands in the west began a little more than 10 years ago. About that time research indicated that much of the root disease damage had been attributed solely to bark beetles.

When pathologists and foresters began to look closely at young-growth stands, they found a surprising amount of root disease-associated mortality. Foresters are now becoming increasingly concerned because damage intensifies with certain management practices and increases throughout the life of the stand. The pathogens persist from one rotation to the next, and are usually impractical to eradicate.

Williams 1/ summarized the root disease problem in the Northern Region in 1971. Since then, R-1 pathologists have devoted considerable time to root disease evaluations. Their observations have not been reassuring as root diseases appear to be especially damaging in Region 1.

This paper is a summary of the problem as it appears now. It describes root disease-caused damage, estimates the losses, states some concerns, and identifies information needs. Its purpose is not to discuss management, but to alert managers to what we believe is an overlooked threat to young-growth timber production.

1/ Williams, R. E. 1971. The root rot problem in the Northern Region. USDA Forest Service, R-1, Insect and Disease Rept. 71-43.

THE LOSSES

Root diseases are caused by fungi that decay or kill the roots of living trees. The effects of root diseases are outright tree killing, predisposition to insect attack, windthrow, growth loss, butt rot, reduced site productivity, and removal of land from timber production. The following examples describe common types of damage in Region 1. Much overlap occurs between types, and two or more types of damage may be present in one stand.

Example 1. Mortality Centers

A root disease mortality center is an area on which most trees have been killed by root disease (figure 1). Size varies from less than 1 acre to more than 100 acres. Typically, the margin is ringed with dead and dying trees and the interior contains regeneration or brush. Young trees within the center usually die before reaching merchantable size. Windthrown trees may be common.

Figure 1.--A large root disease mortality center that is ringed with dead and dying Douglas-fir. The center has regenerated with Douglas-fir that is also dying.

Any of several root pathogens may cause mortality centers. Frequently two or more pathogens are present in the same center. Armillaria mellea or Phellinus weirii are found most commonly in Region 1.

Economic loss results from the killing of merchantable trees, windthrow, butt rot, and loss of site productivity. Regeneration costs are increased. Some centers are no longer producing timber and are filled with brush or nonstocked. Others maintain a limited productivity because they contain tree species that are tolerant of the disease.

Some areas that are out of timber production or have reduced productivity will remain so indefinitely in spite of management efforts; all suitable tree species for the site are susceptible. Regeneration with disease-tolerant species is practical on other sites, but substantial expenditures may be required to prepare the site and plant.

We have been surveying the National Forests of the Region for root disease mortality centers during the past few years. Estimates of acreage infested are calculated from aerial photographs and ground plots. Mortality centers on National Forests surveyed to date occupy 0.4 to 5.1 percent of the commercial forest land (table 1); about twice that amount is actually infested. 2/

Table 1.--Commercial forest area occupied by root disease mortality centers in National Forests surveyed to date.

	Mortality centers 1/	
National Forest	Acres	%
Coeur d'Alene	30,049	5.1
Kaniksu	6,596	0.8
St. Joe	3,380	0.6
Panhandle	40,025	1.9
Nezperce	9,352	1.0
Clearwater	4,863	0.4
TOTAL - North Idaho	54,240	1.3
Lolo	19,796	1.2

1/ Mortality centers are defined as areas occupied by dead and dying trees. Total infested area, including acreage occupied by infected trees that do not yet exhibit root disease symptoms, is about twice that occupied by mortality centers.

2/ Wallis, G. W. and W. J. Bloomberg. 1981. Estimating the total extent of *Phellinus weirii* root rot centers using above- and below-ground disease indicators. Can. J. For. Res. 11: 827-830.

Example 2. Scattered Mortality.

Some stands have persistent root disease associated mortality that occurs in small groups or single trees rather than in large centers (figure 2). Trees of all ages and sizes may be killed directly, or following bark beetle attack. A. mellea is the apparent cause in most areas, but Fomes annosus, P. weirii and other pathogens are also common.

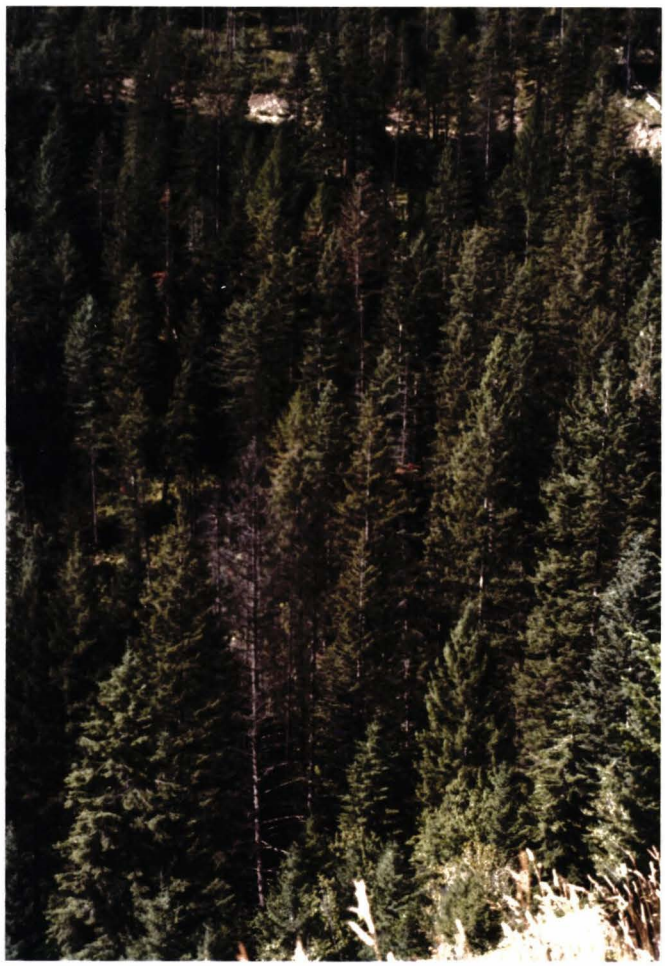

Figure 2.--A Douglas-fir stand with scattered root disease infected dead and declining trees.

Economic loss results from the killing of merchantable trees, reduction of stocking below desired levels, and increased costs of regeneration. Losses per acre are generally lower than in large mortality centers since all trees in the infested area are not killed. However, it appears that partial cutting increases mortality rates in these stands, and severe mortality can occur within 2 to 5 years after cutting.

Surveys on two Idaho National Forests show that acreage in scattered mortality is much greater than in mortality centers. About 14 percent of commercial forest land on the Clearwater NF and 33 percent on the Nezperce NF have at least one root disease-killed tree per acre (about 0.1 tree/acre/year).

Example 3. Regeneration Problems.

Unlike most other diseases, cutting the trees won't necessarily solve a root disease problem because the pathogens can persist in the roots and stumps of cut trees from one rotation to the next. A regeneration cut will remove the diseased trees, but within 5 to 15 years regeneration usually begins to die as the new roots come in contact with these reservoirs of inoculum (figure 3). A. mellea, P. weirii and F. annosus are common in young stands and plantations in the Region. There is some evidence that tree cutting spreads and intensifies root disease.

Figure 3.--Planted white pines killed by root disease. Roots of dead and dying trees were infested with A. mellea from stumps of the previous stand.

We have no acreage estimate of the root disease regeneration problem. But, it is easy to find root disease mortality in plantations in most northern Idaho and western Montana forests.

Example 4. Butt Rot and Indirect Mortality.

Some stands have low mortality rates in spite of root disease. Phaeolus schweinitzii decays roots and the lower bole (figure 4).

Figure 4.--A ponderosa pine that was weakened by brown cubical butt rot, predisposing it to windthrow.

Economic loss results from windthrow of trees that have lost supporting roots, defect in the butt log, and mortality that occurs when A. mellea or bark beetles attack weakened trees.

P. schweinitzii is a very common root pathogen in the Region, but the losses it causes have not been measured.

Region-wide root disease losses. Losses from root diseases in the west are not well documented. We began surveys to remedy this a few years ago, and are still several years away from completing the task. But we have extrapolated from the data we have on root disease losses and calculated interim estimates of loss. Root diseases kill an average of 80.7 MM feet^3 (387 MM bd. ft.) each year (table 2). Growth equivalent to about 13.5 MM feet^3 (60.8 MM bd. ft.) is foregone each year because of reduced site productivity (table 3). For comparison, the average annual timber harvest for 1977-1981 was 202 MM feet^3 (969 MM bd. ft.). About 30 percent of the total annual mortality in the Region is associated with root disease.

Table 2.--Annual root disease associated tree mortality on commercial land in Region 1.

Ownership	Total mortality [1] (MM ft^3/yr)	Root disease associated mortality [2] (MM ft^3/yr)
N. Idaho		
Nat. For.	82.4	24.3
Other	29.9	8.8
Both	112.3	33.1
W. Montana		
Nat. For.	80.1	23.6
Other	29.9	8.8
Both	110.0	32.4
E. Montana		
Nat. For.	22.3	6.6
Other	29.5	8.7
Both	51.8	15.3
Totals		
Nat. For.	184.8	54.4
Other	89.3	26.3
Both	274.1	80.7

1/ Total mortality estimates from Green, A. W. and T. S. Setzer, 1974. The Rocky Mountain timber situation, 1970. USDA For. Ser. Res. Bull. INT-10, 78 p.

2/ Root disease-caused estimates are total mortality x .29456. X (the fraction of the total killed by root disease on the Nezperce and Clearwater National Forests).

Table 3.--Annual growth foregone because of root disease reduction in site productivity.

Ownership	Comm. for. (acres)	Root disease 1/ (acres)	Growth foregone 2/ (MM ft^3/yr)
N. Idaho			
Nat. For.	4,230,686	54,240	
Other	3,485,700	45,315	
Both	7,716,386	99,555	6.6
W. Montana			
Nat. For.	6,175,000	-	
Other	3,754,200	-	
Both	9,929,200	99,292	4.9
E. Montana			
Nat. For.	3,424,700	-	
Other	2,496,700	-	
Both	5,921,400	59,214	2.0
Totals			
Nat. For.	13,830,386	-	
Other	9,736,600	-	
Both	23,566,986	258,061	13.5

1/ Area in root disease mortality centers was calculated from northern Idaho National Forest survey data, and projected to other Idaho ownerships. We used an estimate of 1 percent for Montana.

2/ Loss in productivity was estimated to be 83 percent of average annual yield of 80, 60, and 40 ft^3/A/yr in northern Idaho, western Montana, and eastern Montana respectively. Eighty-three percent was lost from a typical root disease center in western Montana.

CONCERNS

Root diseases are serious pests threatening future timber productivity. They may be especially serious in the long run because they persist throughout the rotation and carry over from one rotation to the next.

Pathologists in Region 1 devote most of their time to this problem. About two-thirds of the R-1 pathology service trips and evaluations deal with the management of root-diseased stands. 3/ These efforts, however, appear to be inadequate.

1. Root diseases aren't fully considered in timber sales and silvicultural prescriptions.

Root pathogens are difficult, if not impossible, to eradicate. The goal must be to prevent infection whenever possible and to reduce losses in infested stands through silvicultural practices. Stand treatments have the potential to either reduce or increase losses.

Yet, many foresters and even certified silviculturists are not well equipped to recognize and manage root disease. Foresters have been receptive to root disease training that has been provided, both formally and informally. But they sometimes still fail to recognize large and obvious root disease centers, mark leave trees with obvious root disease crown symptoms, and thin stands without regard to the root disease killing that is taking place. The Region needs more emphasis on root disease training and management.

2. Regional and forest plans don't fully account for root disease losses in young-growth stands.

It appears that our most serious losses from root diseases will be in stands of the future. This is because most root diseases are diseases of the site (carried over from one rotation to the next) and because they are progressive diseases (intensify with time). Yet, their effects over time have not been adequately accounted for in timber growth and yield projections. Stand prognosis models do not have root disease subroutines or mortality subroutines that adequately account for losses caused by root disease. Existing models include some of the effects of root disease because they are based on data from actual stands, some of which were diseased. But growth and yield projections may still be inaccurate since inventory plots that fall within fully regenerated root disease centers are projected at full productivity even though most trees will not reach merchantable size. Also, the average mortality projected does not account for the high variability between stands.

3/ This paper speaks mainly to the Forest Service program. Idaho has a State forest pathologist who also devotes considerable time to root disease technical assistance. Montana has no State forest pathologist.

3. Timber management practices may be intensifying root disease.

Some pathogens are spread by cutting. F. annosus centers are initiated when windborne spores land on freshly cut stump surfaces. Verticicladiella wagenerii is transmitted by insects that are apparently attracted to cutover areas; new infections are most common along roadways in plantations and other "disturbed" sites.

We have been less concerned about the intensification of A. mellea and P. weirii. Efficient, long-range transmission mechanisms are not known. However, observations suggest these pathogens sometimes intensify greatly when lightly infected stands are partially cut leaving a large food base of residual stumps and large roots. If we are spreading root disease as a result of cutting practices, the implications are serious. The intensification of damage that might otherwise accrue over many decades, perhaps several rotations, may take place within perhaps a decade during which several sanitation-salvage cuts are made. We lack the data that would show to what degree root disease damage has intensified in the northwest. Observations made in this Region, Region 6, and in British Columbia indicate, however, that damage has increased greatly in many stands.

4. Forest Pest Management budgets don't adequately reflect the importance of root diseases.

Forest Service Regions are funded for technical assistance, special projects, and suppression projects.

Suppression is not often a feasible approach to root disease control. Pathogens persist in roots of living and dead trees and stumps; stump removal is the only suppression method currently known to be biologically effective and may not be cost-effective on most stands in R-1.

During recent years the emphasis has been changing from suppression to integrated pest management in the sense that pest management is integrated with forest management. It is especially appropriate to emphasize root disease silvicultural prevention and loss reduction in forest management since remedial action is expensive and often impractical. Since root disease management is accomplished through forest management, Cooperative Forestry and Pest Management's major role is technical assistance.

Pest Management budgets have been reduced in FY 1982 and may be decreased further in future years. This may mean a deempahsis of technical assistance to foresters, resulting in reduced training, service trips, and evaluations that are crucial to silvicultural control.

5. Little root disease research is underway.

The Forest Service has given root diseases little research emphasis here or in other parts of the west. An estimated five SY's [4/] are currently devoted to root diseases in the west, and this number may be reduced to

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4/ Scientist years.

three in FY 1983. Of these, less than one SY is devoted to research on root diseases that are relevant to this Region. No research at all has been done on root diseases in Montana.

The lack of research has made it difficult to develop sound management recommendations. Many of our recommendations are based on observations or extrapolations from other Regions and from Canada where conditions may be considerably different.

INFORMATION NEEDS

We have made no attempt to describe a research and action program to adequately deal with the problem but we have outlined some key needs. They have been classified as special projects or research. There is considerable overlap and some of the work could most effectively be done as cooperative projects between research and NFS.

SPECIAL PROJECTS. Special projects are surveys, demonstrations, pilot tests, and other short-term projects that are a National Forest System responsibility. The Region has a minimal program in some of the areas listed below and more effort is needed.

1. Root disease mapping. The lack of information on the location of root disease infestations makes it difficult to consider root disease effects in forest planning, and to schedule high loss stands for early harvest. Severe infestations can sometimes be seen from the air or recognized on aerial photographs. Chronic bark beetle infestations are sometimes indicators of root disease and R-1 pathologists are checking the feasibility of root disease mapping from previous aerial surveys.

2. Losses in proposed timber sale areas. Few of the Region's stands have been surveyed for root disease. In Region 6 such surveys made at land managers' request now occupy most of three pathologists' time. The surveys measure the rate of loss and evaluate the causes of the losses so that management alternatives can be developed and incorporated into silvicultural prescriptions.

3. Losses in young-growth stands and plantations. The greatest potential for losses from root disease is in our young stands. Mortality is common by age 10-15. Evaluation plots are needed to monitor the progress of disease in these stands and to determine what effect the pathogens will have on stocking and to determine which tree species are least damaged. We need to know what types of plantations and young stands can be brought to merchantable size without unacceptable losses.

4. Survey for causal agents. A major barrier to our use of root disease research findings is our inability to accurately diagnose cause of root disease. Signs of A. mellea are common throughout the Region, yet we know that sometimes other pathogens (P. schweinitzii, V. wagenerii, and F. annosus) predispose the trees to A. mellea but are undetected by the common practice of chopping into the root crown. If we can examine the entire root system of windthrown, blasted, or bulldozed trees we can make management recommendations based on all causes of the problem.

5. Region-wide impact. Several Forests have been surveyed to quantify root disease losses. However, these surveys have been deferred due to financial constraints. Root disease loss estimates are still needed so that appropriate research and management programs can be developed.

RESEARCH. The following research areas are high priority for the Region.

1. Etiology of root disease. Which of the several pathogens found in root disease centers are the cause of tree mortality? Which are secondary? Why does A. mellea appear more aggressive here than in other parts of the world? Are there underlying stand and site characteristics that make stands vulnerable to root disease? How can the true cause of root disease be determined without uprooting the entire tree? It is essential that we base management recommendations on a knowledge of the true cause(s).

2. Risk rating. There appear to be relationships between root disease and soil characteristics, habitat type, and vegetation type. What is this relationship? What are the indicators of high hazard sites? A risk rating procedure is needed for both P. weirii and A. mellea.

3. Thinning and partial cutting. Do thinnings and partial cuttings increase mortality rates? In which stands? Under what conditions should thinning and partial cutting be deferred? What tree species should be favored when thinning? We need the ability to predict the effects of cultural treatments on root-diseased stands.

4. Regeneration guidelines. What tree species are most tolerant to the Region's major pathogens? We need regeneration guidelines for root-diseased areas.

5. Root disease modeling. A modeling capability is needed to predict root disease effects, especially in young-growth stands.

CONCLUSION

Ten years ago Williams expressed the concern that root rot problems in R-1 might increase with timber management as they have in other parts of the world. Observations made since then suggest that they will, and that the increase may sometimes be rapid. We don't know whether noticeable increases have taken place already, or whether the apparent increase in damage is due to better detection, but the threat of root disease is at least as real as it was 10 years ago. It appears that a more intensive effort is needed to answer questions regarding root disease management and to better apply the information we do have.